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ORIGINAL RESEARCH

A Study of Serum Electrolytes in Thyroid Patients Attending A Tertiary Care Hospital

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ABSTRACT

Background: The aim is to study the serum electrolyte levels in thyroid patients attending a tertiary care hospital.

Materials and Methods: Thyroid hormones plays vital role in maintaining body's metabolism, BMR, thermoregulation and hemodynamic status and present study was prospective study done in the patients attending TRR Medical College & Hospital. The study was conducted over duration of 2 years from December 2019 to June 2021. All the patients in the age group of 18- 40 years were taken in the study. Total 100 patients were included in the study (50 cases, 50 controls) to study the evaluation of serum electrolytes on thyroid patients.

Results: In the present study, with respect to association of cases and controls with age, no significant causation was seen. In this study thyroid patients have no association with age, with not much mean difference in age of cases (32.11 years) and controls (30.02) years. Thyroid cases were found to be more females (90%) as compared to males (10%), but the association of sex with disease is not significant. This further concludes that though females are commonly affected with thyroid disorders, but their association is by chance and not significant. All serum electrolytes (Na+, K+, Cl-), TSH shows a positive relationship it signifies that as TSH increases in patient the level of these electrolytes also increases, but this relationship of TSH with all the electrolytes was not significant (p>0.05).

Conclusion: This study suggests that the estimation of serum electrolytes in thyroid patients would be helpful to avoid further complications of electrolyte imbalance.

Keywords: Thyroid, TSH, Hypothyroidism, Electrolytes.

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INTRODUCTION

An electrolyte is a substance that conducts electricity when dissolved in water. It is another name for body's ions, i.e. those molecules which are electrically-charged. They are used by cells to create and carry voltages across cell membranes, i.e. they are part of the communications between cells.

Electrolytes are primarily composed of the minerals sodium, potassium, magnesium, calcium, plus chloride, phosphates and sulfates. They are essential for a number of bodily functions. They regulate nerve and muscle function, hydrate the body, balance blood acidity and

pressure, and help rebuild damaged tissue. A balance of different electrolytes is vital for healthy function.

Thyroid hormones plays vital role in maintaining body's metabolism, BMR, thermoregulation and hemodynamic status. Thyroid hormones regulate the metabolism of carbohydrate, protein, Lipids, electrolytes and minerals. The effect and the underlying mechanism of action of thyroid hormones on electrolytes and mineral metabolism is not well known. Hyponatremia, clinical features include dehydration, drop in blood pressure, drowsiness, lethargy, confusion, abdominal cramps, oliguria, tremors and coma. Hypothyroidism is accompanied by remarkable alterations in the metabolism of water and electrolytes3-4. Sodium and potassium are important components of the enzyme sodium potassium ATPase which is a cell membrane

enzyme that helps in the transport of water and nutrients across the cell membrane. Thyroid hormones regulate the activity of sodium potassium pumps in most of the tissues Prospective studies show that hypothyroidism is associated with hyponatraemia. Plasma potassium level above 5.5 mmol/L is known as hyperkalemia. Since the normal level of K+ is kept at a very narrow margin, even minor increase is life-threatening. In hyperkalemia, there is increased membrane excitability, which leads to ventricular arrythmia and ventricular fibrillation. Hyperkalemia is characterized by flaccid paralysis, bradycardia and cardiac arrest. ECG shows elevated T wave, widening of QRS complex and lengthening of PR interval. Any disturbance in the electrolytes is life threatening.

Many literatures have reported changes in the serum electrolytes concentration and shown their association with thyroid dysfunction. Thyroid hormones regulate the activity of sodium potassium pumps in most of the tissues. Sodium and potassium are important components of the enzyme Na+-K+ATPase, which is an enzyme on the cell membrane that helps in the transport of water and nutrients across the cell membrane. Most guidelines consider hypothyroidism to be a cause for hyponatremia. Proposed mechanisms for hypothyroidism induced hyponatremia include increase in vasopressin (ADH) release and reduced renal glomerular filtration rate (GFR). On the other hand, hypokalaemia, hypomagnesaemia and hypercalcaemia were mentioned in patients with thyrotoxicosis.So, as the effect on thyroid hormones on electrolytes has not been well established and the underlying mechanisms are not well understood. Significant scientific work has been done earlier to correlate electrolyte in other disease states mentioned above and their effects on prognosis of the disease, but very few studies are currently available to assess association of thyroid disorders and disturbances in the serum electrolytes equilibrium in thyroid patients, and these studies indicate mean low serum sodium, potassium and chloride levels in the patients suffering from hypothyroidism21. This association once established would help the clinician to modify the clinical course of the disease, and help prevent unwanted complications of altered electrolytes equilibrium of thyroid patients.

Thus our aim was to assess the levels of serum electrolytes in patients with thyroid disorders and the present study was undertaken to assess the alterations in the levels of serum electrolytes in hyperthyroid, hypothyroid and euthyroid patients. This study is undertaken to assess the relationship of electrolytes in thyroid patients which in turn help the clinician in better clinical management of thyroid patients seeking medical advice with complications of electrolytes imbalance.

Aim:

To study the levels of serum electrolytes in thyroid patients attending a tertiary care hospital.

Objectives:

1. To assess the relationship of electrolytes in thyroid patients.

2. To help the clinician in better clinical management of thyroid patients seeking medical advice with complications of electrolytes imbalance.

MATERIALS & METHODS

Study Period:

The study was conducted over duration of 2 years from December 2019 to June 2021 in TRR Medical College & Hospital.

Study population:

All the patients in the age group of 18-40 years were taken in the study. Patients who reported for treatment at the outpatient ward of TRR Medical College & Hospital were recruited for this study. Patients were prior made to understand that it was not a hospital obligation for them to participate in the research and neither it was a pre-requisite to access routine medical services. Written informed consent forms were distributed and explained to the participants one week prior to the beginning of the samples collection.

Study Design:

The present study was prospective study done in the patients attending TRR Medical College & Hospital.This study was approved by the Institutional Ethics Committee.
Informed consent in the patient's regional language along with demographic details and presumptive health checkup report was taken before analysis of sample. The demographic data, clinical presentation and laboratory tests details were recorded for each case (proforma enclosed).

Inclusion Criteria: Patients in the age group of 18-40 years were taken for the study.
Exclusion Criteria: Patients with following conditions were excluded.

(a) Patients age below 18 years and above 40 years
(b) Chronic Diseases like diabetes, renal, liver and heart diseases
(c) Recent Infections ex; tuberculosis, acute severe sepsis
(d) Severe Dehydration like in acute gastro enteritis and sunstrike etc. which known to cause abnormal electrolyte levels
(e) Patients on medications which known to interfere with tests results like anti tubercular and malarial drugs.

Mode of Collection:

(a) 12 hours fasting venous samples of patients and controls were analysed.
(b) Data collection as per proforma.

Methods of analysis

After collecting informed consent in the patient's regional language along with demographic details were taken from the patients, about 3ml of 12 hours fasting venous samples were collected after proper aseptic precautions from the patients and controls. Samples were stored at 4ºC. samples were centrifuged and Thyroid Profile (T3,T4,TSH) performed using Chemilumenscence method (CLIA). Serum Electrolytes (Na+ K+ Cl-)estimated by Ion Selective Electrode (ISE).

Electrolyte profile test

A test for electrolytes includes the measurement of sodium, potassium, chloride, and bicarbonate. These ions are measured to assess renal (kidney), endocrine (glandular), and acid-base function, and are components of both renal function and comprehensive metabolic

biochemistry profiles. Other important electrolytes routinely measured in serum or plasma includes calcium and phosphorus. These are measured together because they are both affected by bone and parathyroid diseases, and often move in opposing directions. Magnesium is another electrolyte that is routinely measured. Like calcium, it will cause tetany (uncontrolled muscle contractions) when levels are too low in the extracellular fluids.

Measurement of electrolytes

Electrolytes are measured by a process known as potentiometry. This method measures the voltage that develops between the inner and outer surfaces of an ion selective electrode. The electrode (membrane) is made of a material that is selectively permeable to the ion being measured. This potential is measured by comparing it to the potential of a reference electrode. Since the potential of the reference electrode is held constant, the difference in voltage between the two electrodes is attributed to the concentration of ion in the sample.

RESULTS

Table 1: Comparison of T3, T4, TSH, Sodium, Potassium, Chloride in Cases and Controls

Parameters	Mean±SD		t value	p value
	Cases	Controls		
T3	0.91±0.33	1.21±0.21	3.52	0.001*
T4	8.13±5.51	8.66±0.81	0.613	0.94
TSH	29.1±38.71	2.56±1.10	5.24	0.01*
Na+	138.21±2.92	143.81±4.86	12.91	0.001*
K+	4.01±0.41	4.52±0.43	6.23	0.001*
Cl-	105.81±13.32	101.52±1.82	3.01	0.01*

The above table shows the comparison among cases and controls in terms of Thyroid profile and serum electrolytes. As seen the thyroid profile (T3,T4, & TSH) except T4, both T3 and TSH were significantly associated (p value- 0.001,0.01) when cases compared with controls. This concludes that T3,TSH are more commonly associated then T4. As per serum electrolytes (sodium, potassium & chlorides) shows significant association with cases which further concludes that serum electrolytes have positive association with Thyroid patients.

Table 2: Association of cases and controls in terms of Age

Variables	Age in years (mean±SD)	t-value	p value
Cases	32.11 ±10.80	0.884	0.88
Controls	30.04±7.43	0.978	0.74

With respect to association of cases and controls with age, no significant causation was seen. This concludes that in thyroid patients has no association with age, with not much mean difference in age of cases (32.11 years) and controls (30.04) years as per [Table 2].

Table 3: Sex wise distribution of study participants

Gender	Cases		Controls		χ^2,df, p-value
	No.	%	No.	%	
Male	5	10	10	20	2.15,1,0.15
Female	45	90	40	80	

As per [Table 3] number of thyroid cases were found to be more females (90%) as compared to males (10%), but the association of sex with disease is not significant. This further concludes that though females are commonly affected with thyroid disorders, but their association is by chance and not significant.

Table 4: Comparison of Laboratory variables in Males

Variables	Mean ±SD		t-value	p-value
	Males (cases)=8	Males (controls)=14		
T3	1.04±0.42	1.32±0.221	1.993	0.72
T4	6.28±4.11	8.82±0.83	2.23	0.01*
TSH	40.53±49.81	2.51±1.14	2.4	0.01*
Na+	135.14±2.41	141.04±4.82	3.15	0.02*
K+	4.15±0.65	4.69±0.41	2.21	0.02*
Cl-	108.09±3.191	101.72±2.42	5.21	0.001*

[Table 4] shows the comparative values of different serum electrolytes and thyroid markers studied in thyroid cases and controls in males, as seen except T3 all the electrolytes were significantly associated with males. This concludes the significance of T3 is not much as compared to other thyroid markers in thyroid patients though it is a vital marker, but no association has been seen with males in the present study, while TSH is highly raised in cases (40.53) as compared to controls (2.51) with significant association. In terms of serum electrolytes, chloride is found to be highly significant (p-value= 0.001).

Table 5: Comparison of Laboratory variables in females

Variables	Mean ±SD		t-value	p-value
	Females (cases)=52	Females (controls)= 46		
T3	0.95±0.47	1.16±0.244	2.71	0.01*
T4	8.45±5.71	8.653±0.81	0.20	0.06
TSH	27.71±38.22	2.54±1.08	4.43	0.001*
Na+	136.21±3.05	141.72±4.91	6.62	0.001*
K+	4.06±0.32	4.45±0.43	4.51	0.001*
Cl-	105.61±12.29	101.41±1.62	2.43	0.01*

[Table 5] shows the comparative values of different serum electrolytes and thyroid markers studied in thyroid cases and controls in females, as seen except T4 all the electrolytes were significantly associated with females. This concludes the significance of T4 is not much as compared to other thyroid markers in thyroid patients (females) though it is a vital marker, but no association has been seen with females in the present study, while TSH is highly raised in cases (27.71) as compared to controls (2.54) with significant association. In terms of serum electrolytes, potassium is found to be highly significant (p-value= 0.002).

[Table 4 and Table 5] shows association of male and females patients with different serum electrolytes and thyroid markers. It can be concluded that T3 is not significant in males while in females T4 is not significant which further concludes the importance of thyroid markers in terms of gender. In both the scenarios TSH was found to be most diagnostic thyroid marker.

Table 6: Correlation with Serum Sodium, Potassum and Chloride levels with TSH

Variables	Correlation coefficient (r)	p-value
TSH Vs Na+	0.110	0.06
TSH Vs K+	0.051	0.05

TSH Vs Cl-	0.004	0.08

[Table 6] shows the relationship between serum electrolytes and TSH as it was found to be most efficient thyroid marker in both sex. As seen with all serum electrolytes (Na+, K+, Cl), TSH shows a positive relationship it signifies that as TSH increases in patient the level of these electrolytes also increases, but this relationship of TSH with all the electrolytes was not significant ($p>0.05$).

DISCUSSION

The observations and results of the study entitled "A Study of Serum Electrolytes in Thyroid Patients Attending a Tertiary Care Hospital" are compared in this chapter in the light of available data, information and observation made by other workers in similar region or elsewhere.

Socio-demographic characteristics of the study participants

In the present study number of thyroid cases was found to be more females (90%) as compared to males (10%), but the association of sex with disease is not significant. This further concludes that though females are commonly affected with thyroid disorders, but their association is by chance and not significant. In a study conducted by L.B.Sapkota, more than three- fourth (79.4%) of the hypothyroid patients was female. Majority (50.0%) of them fall in age- group 40 to 59 years. This indicates that hypothyroidism is more common in middle-aged females. This finding is supported by earlier statistics which suggested much higher prevalence of hypothyroidism in women compared to men. Mean age in the present study concludes that in thyroid patients has no association with age, with not much mean difference in age of cases (34.18 years) and controls (32.08) years. The result of the study was similar to findings of Roopa et al and Bharti et al.[1,2]

Comparison of different Laboratory Parameters of the study participants

The present study showed the thyroid profile (T3, T4, & TSH) except T4, both T3 and TSH were significantly associated (p value=0.001, 0.01) when cases compared with controls. This concludes that T3, TSH are more commonly associated than T4.

As per serum electrolytes (sodium, potassium & chlorides) shows significant association with cases which further concludes that serum electrolytes have positive association with Thyroid patients. The comparative values of different serum electrolytes and thyroid markers studied in thyroid cases and controls in males, as seen except T3 all the electrolytes were significantly associated with males. This concludes the significance of T3 is not much as compared to other thyroid markers in thyroid patients though it is a vital marker, but no association has been seen with males in the present study, while TSH is highly raised in cases (40.53) as compared to controls (2.51) with significant association. In terms of serum electrolytes, chloride is found to be highly significant (p-value=0.001). In females, as seen except T4 all the electrolytes were significantly associated with females. This concludes the significance of T4 is not much as compared to other thyroid markers in thyroid patients (females) though it is a vital marker, but no association has been seen with females in the present study, while TSH is highly raised in cases (27.71) as compared to controls (2.54) with significant association. In terms of serum electrolytes, potassium is found to be highly significant (p-value=0.002).

In the study conducted by L.B.Sapkota we found significant decrease in serum sodium levels. This finding is in accordance with Schwarz et al. and Roopa et al. who stated hyponatremia is a common finding in patients with hypothyroidism.[2,3]

In contrast to hyponatremia, serum potassium levels were significantly raised in the present study. This finding is supported by Abedelmula M et al. and Bharti et al. who stated there was significant increase in serum potassium levels in hypothyroid group compared to controls.[4]Horie et al also reported hyperkalemia in a small percentage of hypothyroid patients after thyroid hormone withdrawal.[5]

Roopa and Soans reported that thyroxin normally regulates blood calcium level by releasing calcium from cells, by decreasing thyroxin level in blood, less T4 enters the cells and less calcium is released.[2] A study done by Suneel et al, who reported that there was a significant decrease of the mean phosphate in patients with hypothyroidism compared to control. This is mainly due to calcitonin which is regulates the over tubular reabsorption of phosphate from kidney. Phosphate levels are raised due to compensatory effect of calcitonin and parathormone which favour tubular excretion (by inhibiting tubular reabsorption).[6]

Patients with SCH and hypothyroidism showed significantly high levels of serum magnesium levels as compared to normal controls ($p<0.05$). Our result was supported by Jaskin K, Schwarza and Frizel.[7-9]Frizel in his study states that both plasma magnesium and ionized magnesium were increased in hypothyroidism. Murgud et al exhibited significantly elevated levels of serum magnesium compared to the controls ($p<0.05$). However statistically significant difference was seen in the level of sodium ($p<0.05$) in case of hyperthyroid patients.[10]

A retrospective study showed that acute hypothyroidism in the setting of thyroid hormone therapy withdrawal in patients with differentiated thyroid cancer was associated with mild hyponatremia in only 3.9% of 128 patients, whereas none of the patients developed severe hyponatremia.[11] Similarly, in a prospective analysis of 212 consecutive thyroid cancer patients, a small difference was observed between pre- and post-isolation sodium levels (mean±s.d. preisolation: 139.5±2.3, post-isolation: 137.8±3.0mEq/L).[12] Additionally, mild hyponatremia (≥130mEq/L) was observed only in 18 patients (8.5%) and moderate hyponatremia (≥120mEq/L) only in 4 (1.9%) patients.[13]

As per the study by Chen YC et al, renal retention of magnesium was due to 15-30% increased reabsorption of the filtered magnesium in thyroid deficient rats at any given plasma concentration as the thyroid hormones had direct effect on the tubules. Thyroid hormones determine the mineral pool in the blood by regulating mobilization of calcium, phosphorous and magnesium into the blood and their clearance through urinary excretion due to their effect on GFR/ renal plasma flow.[14,15]

A statistically significant decrease in serum sodium is observed in cases compared to controls in our study ($p<0.0001$). Our study is in accordance with study conducted by Derubertiset al.[16] A statistically significant decrease in serum potassium was observed in cases compared to controls in our study ($p<0.0001$).

Sodium and potassium make vital composition of the enzyme Na-K ATPase, which is an enzyme on the cell membrane helping in the transport of water and essential nutrients across the cell membrane. Sodium potassium pump in most of the tissues are regulated by thyroid hormones. Deficiency of thyroid hormones leading to low potassium levels in hypothyroidism, affect the Na-K ATPase activity leading to accumulation of water inside the cells and causing oedema. This could be one of the mechanisms responsible for weight gain seen in hypothyroid patients.[17] A statistically significant increase in serum chlorides is observed in cases compared to controls in our study ($p=0.02$).

Correlation of different laboratory variables with TSH

In the present study the relationship between serum electrolytes and TSH was found to be most efficient thyroid marker in both sexes. As seen with all serum electrolytes (Na+, K+, Cl-), TSH shows a positive relationship it signifies that as TSH increases in patient the level of

these electrolytes also increases, but this relationship of TSH with all the electrolytes was not significant ($p>0.05$)

The activity of Na+/K+ ATPase pump is decreased leading to the reduction of Na+ reabsorption. Hyponatremia is one of the commonest electrolyte derangement in hypothyroid patients because hypothyroidism is associated with decreased GFR, decreased renal plasma flow and decreased sodium reabsorption. Other possible mechanism of hypothyroidism induced hyponatremia is an inappropriate ADH secretion syndrome (SIADH)-like disorder18. It is a well-established fact that hyponatremia is associated with hypothyroidism, but it is not known if hypo- or hyperkalemia is associated with hypothyroidism. Hyperkalemia observed in this study might be implicated to changes in the renal hemodynamics and deficient ADH secretion resulting in decreased Potassium excretion which occurs in hypothyroid patients.

Negative correlation between TSH and serum sodium level among cases is observed. Our study is in accordance with study conducted by Montenegro et al19. Negative correlation between TSH and serum potassium level among cases was observed. Our study is in accordance with study conducted by Jaskiran Kaur et al.[7]

CONCLUSION

The present study was a hospital based prospective study. Thyroid hormones are involved in metabolism of carbohydrate, lipid, protein and electrolytes, the hypothyroid patients generally suffer from a slow metabolism resulting in electrolyte disturbances. Our study demonstrated that hypothyroid patients show serum electrolyte disturbances such as low sodium, low potassium and low calcium levels. Our study also revealed that females are more vulnerable to hypothyroidism. Hence monitoring of these serum electrolytes during the routine screening of hypothyroid patient will be of great benefit in subjects suffering from hypothyroidism without any clinical manifestation or the patients who are subclinical hypothyroid. Also, electrolyte disturbances need to be monitored and treated appropriately in different conditions such as myxedema coma to avoid the ill effects resulting from the changes in their serum levels.

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